MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

PPC0055 – MECHANICS, WAVES & OPTICS
(All Sections / Groups)

8 OCTOBER 2016
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages including cover page and appendices with FIVE (5) questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

4. All necessary workings **MUST** be shown.

QUESTION 2 (10 MARKS)

a) In Figure **Q2(a)** a car engine with weight w hangs from a chain that is linked at point O to two other chains, one fastened to the ceiling and the other to the wall.
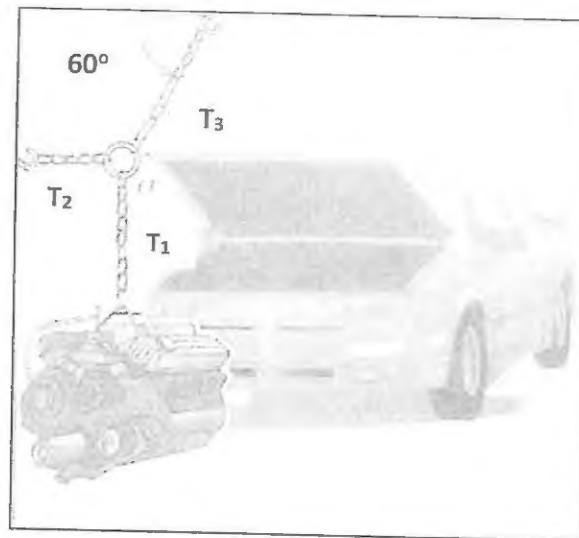

Figure Q2(a)

(i)   Draw the free body diagram for the engine.

[2.5 marks]

(ii)   Given the value of weight w is 2200 N, find the tensions in T_1, T_2 and T_3.

[5 marks]

b) An 1800 kg car stopped at a traffic light is struck from the rear by a 900 kg car and the two become entangled. If the lighter car was moving at 20 m/s before the collision, what is the speed of the entangled cars after the collision? Take the positive x direction to be in the direction of motion of the smaller car.

[2.5 marks]

Continued...

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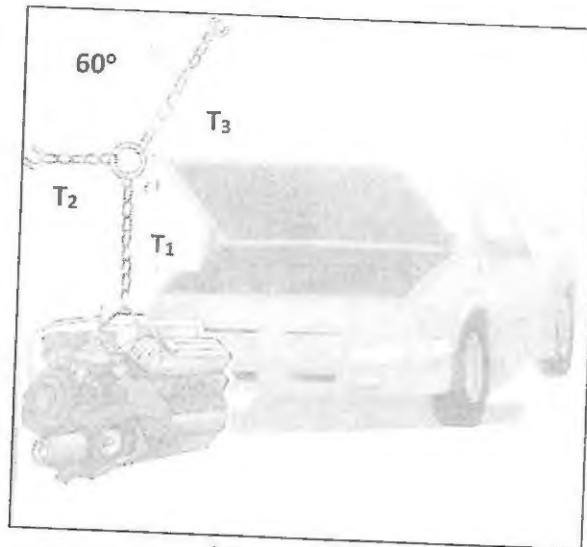

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QUESTION 3 (10 MARKS)

A spring stretches 0.150 m when a 0.300 kg mass is gently attached to it. The spring set up horizontally with the 0.300 kg mass resting on a frictionless table. The mass is pushed so that the spring is compressed 0.100 m from the equilibrium point, and released from rest. Determine

(a)　　the spring stiffness constant k and angular velocity ω.

[3 marks]

(b)　　the amplitude of the horizontal oscillation A.

[1 mark]

(c)　　the magnitude of the maximum velocity v_{max}.

[1 mark]

(d)　　the magnitude of the maximum acceleration a_{max} of the mass.

[2 marks]

(e)　　the period T and frequency f.

[2 marks]

(f)　　the displacement equation x as a function of time.

[1 mark]

Continued...

QUESTION 4 (10 MARKS)

a) The transverse displacement of a string (clamped at its both ends) is given by

$$y(x, t) = 0.06 \sin \frac{2}{3} x \cos(120\pi t)$$

Where x and y are in m and t in s. Answer the following:

   i)   Does the function represent a travelling wave or a stationary wave?

                                                  [1 mark]

   ii)   What is the wavelength, frequency, and speed of each wave?

                                                  [3 marks]

b) A sinusoidal standing wave has a wavelength equal to 0.5 m. Where are its first 3 nodes located?

                                                  [3 marks]

c) A trumpeter plays her trumpet while in a car. The note she plays has a frequency of 300 Hz but you hear a note with a frequency of 280 Hz,

   i)   is she moving towards or away from you?

                                                  [1 mark]

   ii)   how fast is she moving? (Speed of sound in air is 330 m/s)

                                                  [2 marks]

Continued…

QUESTION 5 (10 MARKS)

a) Calculate θ_1, θ_2, θ_3, and θ_4 based on **Figure Q5(a)** below.
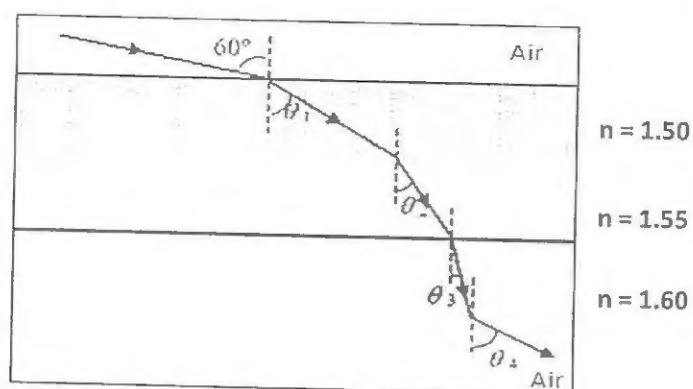
[5 marks]

Figure Q5(a)

b) James has a coherent light source with wavelength 720 nm. He wishes to send light through a pair of slits with the slit separation of 1.90 mm to a screen 98 cm away.

   i) Calculate the minimum width of the screen if James wants to display five interference maxima on the screen.

[3 marks]

   ii) Calculate the distance between adjacent bright fringes on the screen.

[2 marks]

End of Paper.

LIST OF FORMULA

Differential Rule	Trigonometric Identity
$y = kx^n$ $\dfrac{dy}{dx} = knx^{n-1}$	$\sin = \dfrac{opposite}{hypotenuse} \qquad \cos = \dfrac{adjacent}{hypotenuse} \qquad \tan = \dfrac{opposite}{adjacent}$ $\sin\alpha + \sin\beta = 2\cos\left(\dfrac{\alpha-\beta}{2}\right)\sin\left(\dfrac{\alpha+\beta}{2}\right)$ $\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$

NEWTONIAN MECHANICS

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v = v_o + at \qquad x - x_o = v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a(x - x_o) \qquad x - x_o = \left(\frac{v_o + v}{2}\right)t$$

$$v = v_o + gt \qquad y - y_o = v_o t + \frac{1}{2}gt^2 \qquad v^2 = v_o^2 + 2g(y - y_o) \qquad y - y_o = \left(\frac{v_o + v}{2}\right)t$$

$$W = Fs\cos\theta \qquad W = mg \qquad \sum F = F_{net} = ma \qquad f_s \leq \mu_S F_N$$

$$f_k = \mu_K F_N \qquad p = mv \qquad \sum F = \frac{\Delta p}{\Delta t}$$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \qquad m_1 u_1 + m_2 u_2 = (m_1 + m_2)v \qquad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$$

$$K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx \qquad PE_G = mgy$$

$$v_{circular} = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r} \qquad F_g = G\frac{m_1 m_2}{r^2} \qquad U_g = -G\frac{m_1 m_2}{r}$$

$$T^2 = K_s r^3 \qquad T_s = 2\pi\sqrt{\frac{m}{k}}$$

Spring with mass,   Simple pendulum,

$$\omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{g}{l}} \qquad T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f}$$

Cosine Wave:
$$x = A \cos \omega t$$
$$v = -\omega A \sin \omega t$$
$$a = -\omega^2 A \cos \omega t$$

Sine Wave:
$$x = A \sin \omega t$$
$$v = \omega A \cos \omega t$$
$$a = -\omega^2 A \sin \omega t$$

WAVES AND OPTICS

$$v = f\lambda \qquad \omega = 2\pi f \qquad n = \frac{c}{v} \qquad n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin \theta_c = \frac{n_2}{n_1} \qquad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad M = -\frac{d_i}{d_o} = \frac{h_i}{h_o} \qquad f = \frac{R}{2}$$

$$d \sin \theta_{max} = m\lambda \qquad a \sin \theta_{min} = m\lambda \qquad d \sin \theta_{min} = (m + \frac{1}{2})\lambda$$

$$y_{bright} = \frac{m\lambda L}{d} \qquad y_{dark} = (m + \frac{1}{2})\frac{\lambda L}{d} \qquad I = \frac{P}{A} \qquad \beta = 10 \log_{10} \frac{I}{I_o}$$

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right) \qquad y(x,t) = A \sin(kx \pm \omega t + \phi)$$

Wave Type:

$$y(x,t) = 2A \cos\left(\frac{\phi}{2}\right) \sin\left(kx - \omega t - \frac{\phi}{2}\right)$$

$$y(x,t) = 2A \sin kx \cos \omega t$$